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HALLGARTEN & COMPANY

Initiation of Coverage

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Sixth Wave Innovations

(CSE: SIXW, OTC:ATURF, FSE:AHUH)

Strategy: Long

Price (CAD)		$0.75
12-Month Target Price (CAD)		$1.70
Upside to Target		127%
High-low (12 mth)		$0.27 - $1.20
Market Cap (CAD mn)		53.9
Float		75%
Shares O/S (millions)		
	Ordinary	**71.9**
	Options	4.9
	Warrants	13.5

Sixth Wave Innovations

Polymers Revolutionising Mining, CBD & Health Sciences

- + Molecularly Imprinted Polymers have the potential to drive out antiquated usages and drive up recoveries from cyanide-based recovery methods
- + After years of evolution and refinement in academia the technology has come to the attention of public markets with the listing of Sixth wave in February 2020
- + The world of long-standing users of Activated Carbon in Gold processing applications, such as CIL/CIP, is facing major shakeup as the biggest innovation in decades gains traction
- + The technology can reduce costs by around US$100 per oz Au while increasing recoveries
- + Uptake of the MIPs by the likes of Kinross at its Bald Mountain mine in Nevada
- + Potential in Life Sciences is being fast-tracked in the current Coronavirus Crisis
- + The variation for CBD purification (Affinity) promises a new way to cleanse hemp products without the use of harsh solvents, that may become contaminants in themselves
- + Recent announcement of the sale of the first three Affinity units to Green Envy, LLC
- + The polymer beads/membranes can be adapted to different formats (using eluents) for processing of other metals, such as Silver, Lithium, Tungsten and Mercury
- ✘ The mining industry is notoriously slow to adopt new technologies on the processing side
- ✘ Still early days in the applications of MIPs to virus applications
- ✘ There exist, and are in process, alternative purification technologies in the CBD purification space and adoption will require approval of health (and other) authorities in various jurisdictions

Technology Across Disparate Applications

With mining and Cannabis being two mainstays of the Canadian equity markets in recent years it is almost unheard of for there to be a technology or process that straddles the gulf between these two disparate fields of endeavour. Despite this the investors who conjure with one or the other activity are frequently the same universe. So with Sixth Wave Innovation's specialty in Molecular Imprinting Polymers (MIPs) there is a commonality which means those investors in both mining & cannabis should grasp the implications and potential.

Now the company's work, in the background, on health sciences' applications has been fast-tracked in response to the hunt for solutions to the rampaging Coronavirus.

Sixth Wave's nano-engineered product range is based upon polymers. The MIPs field is a specialized science that involves embossing the architecture of a target molecule directly onto advanced polymers. When the target material is stripped away, what remains is a molecular entity with a geometric cavity,

one which can only be filled by the now missing target component (such as valuable metals, naturally occurring pharmaceuticals, or adverse substances such as bacterial markers and explosives).

In turn, when this incomplete molecular entity is released into a process environment, it has a compulsion to complete itself, seeking out valuable materials such as gold and cannabinoids. In the company's view, its process is a materials extraction platform with the capacity to outdistance legacy extraction and purification technologies in most performance categories. In the CBD space in particular there are constantly evolving strains of the plants that are being enhanced for elements such as CBC, CBN, CBG and THC-V which will need more sophisticated technologies for separation that current distillation processes.

SixthWave has two labs, in Salt Lake City in Utah and Maryland (where the health sciences work is undertaken). The company has patents, and patents pending, in over 40 countries. They have commercialized their technology and it has been in use for many years, such as explosives detection in the Iraq war.

In this review we shall look at the new technology, specifically in its applications for gold and the processing of other minerals, but beyond that for other applications, such as CBD purification.

(Mining) Innovation and Its Discontents

The history of the mining industry and its relationship to new technologies has been one of fits and starts. Essentially little changed in the thousands of years pre-mechanisation. At the beginning of the industrial age in the early 1800s a quantum leap was made with steam engines bringing greater water-pumping, lifting, drilling, crushing and ventilation abilities to a hitherto rustic industry. Miners were more than willing to add these life-enhancing (literally) innovations. Electricity followed a few decades later. Since that time many of the innovations that have been added have been on the processing side with a strong component of chemical sciences enhancing extraction techniques from the crushed ore.

One of the common complaints of the more progressive side of the mining engineering community in recent years has been the resistance of mining managements and project consultants to the adoption of new technologies. While exploration techniques has romped ahead with the likes of geochem, aeromag, IP and XRF, the engineering side has still not wrapped its mind around decades old innovations like, for instance, bioleaching (Biox) use in gold recoveries.

The problem that these major innovations have is that introducing them involves a "whole of process" commitment for "whole of mine life" and the cost of failure can be fatal to a venture or project.

An example of a technology that is long overdue for innovation is the Carbon-in-Leach (CIL)/ Carbon-in-Pulp (CiP) processes that have been used for over a century now. Poor recovery is the issue here with more than 10% of gold mined being lost in the cyanide solution using activated carbon.

A recent innovation by Sixth Wave offers a solution to this recovery issue without causing major

disruption or reengineering of the flowsheets of existing CiL/CiP operators in the gold space. The technology has the ability to be extended to other metals, such as Tungsten, Silver and Lithium.

The Path to the Markets

The company was originally called Atom Energy Inc. and it spent a while as a listed entity on the NEX Exchange. In May 2018, it decided to delist from that exchange and seek a better listing environment. In September 2018, it acquired 6th Wave Innovations Corp, a Delaware Corporation which owned the technologies that are now the basis of the company's business. The terms of the transaction were:

- Aggregate consideration of approximately USD$7.7mn, settled with a mixture of securities of Atom (with an approximate value of USD$6.5mn) and cash of approximately USD$1.2mn
- Securities of Atom were issued to 6th Wave shareholders were issued in the so-called Concurrent Financing, which has actually taken place over several years (see table below)
- In the money options and warrants of 6th Wave were settled with securities of Atom, with the amount by which the options and warrants are in the money being paid by the issue of securities of Atom of the same class issued in the Concurrent Financing
- Out of the money warrants of 6th Wave were converted to warrants at a variety of different strike prices and terms based on the Concurrent Financing Price and the extant exercise price of the 6th Wave warrants
- In addition, Atom extended a Bridge Loan to 6th Wave in the principal amount of CAD$1,250,000 in order to fund operations until the closing of the transaction and Atom agreed to repay approximately US$2.4 million of existing indebtedness of 6th Wave on closing, with an additional US$2.1 million to be repaid over the following 24 months

Financing over recent years has evolved as shown in the table below:

Concurrent Financing

Tranche	Date	Type	Number	Funds Received
1	6-May-19	Common Shares	1,333,333	$999,999.75
2	27-May-19	Common Shares	2,946,663	$2,210,000.00
3	25-Jul-19	Subscription Receipts	3,603,600	$2,702,700.00
4	21-Oct-19	Common Shares	3,480,583	$2,610,437.25
5	6-Dec-19	Common Shares	2,000,000	$1,500,000.00
6	20-Jan-20	Common Shares	5,212,559	$3,909,418.50
Total Concurrent Financing			18,576,738	$13,932,555.50

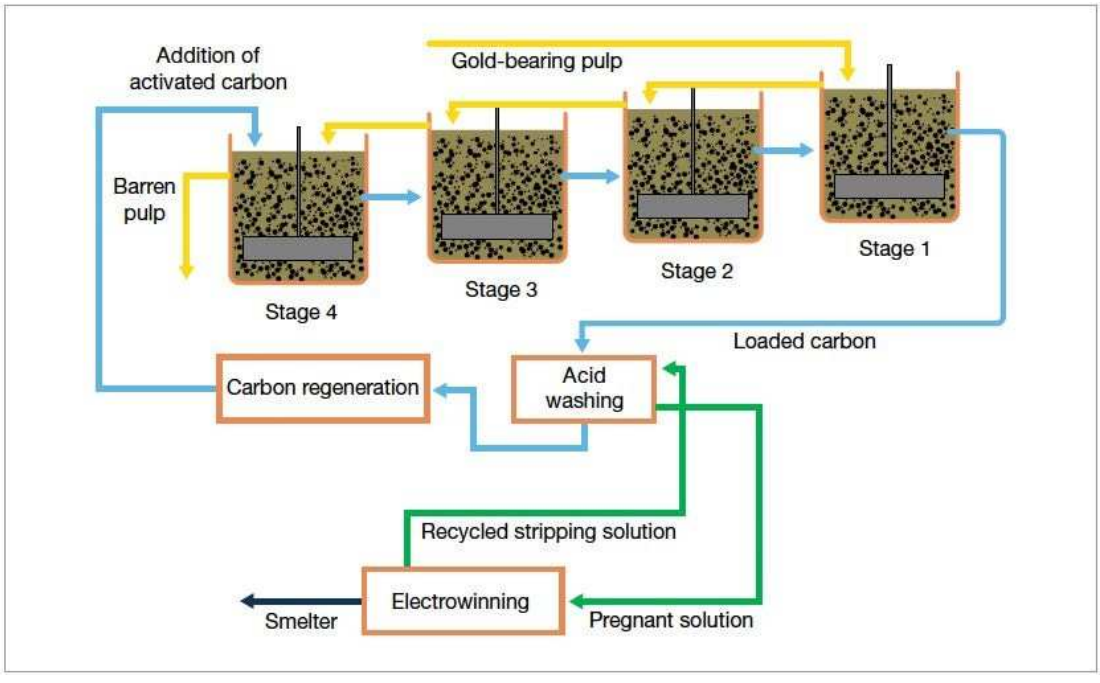
In early February 2020, Sixth wave Innovations began trading on the CSE and the current shareholding structure is shown in the table that at the right.

Share Structure	
Total shares outstanding (as of Feb 2020)	71,850,652
Shares held by insiders	17,859,810
Float	53,990,842
Float %	75%
Options	4,875,000
Warrants	13,493,600
Fully diluted	90,219,252

CIL/CIP – Overdue for Innovation

Extracting gold before the 20th Century was mostly done by using gravity-separation processing. However, since the early 20th Century cyanide leaching has been employed to extract gold from crushed rock. This was a huge breakthrough and makes up a large part of today's mining industry. Cyanide leach helped the South African mines boom in the early 1900's.

Around the turn of the twentieth century two American metallurgists Charles Merril and Tom Crowe came up with a new and improved method which added vacuums and zinc. The crushed ore rock is treated with cyanide, the rock dissolves into solution and is eventually recovered using activated carbon which binds with gold molecular particles. The Merril Crowe system is still widely used today.



Carbon-in-pulp (CIP) is an extraction technique for recovery of gold which has been liberated into a

cyanide solution as part of the gold cyanidation process.

Introduced in the early 1980s, Carbon-in-Pulp is regarded as a simple and cheap process. As such it is used in many industrial applications where the presence of competing silver or copper does not prohibit its use.

Roughly 60% of all gold produced annually has been through some variation of the Gold-Cyanide Process (GCP). For suitable GCP solutions activated carbon is the most common sequestering substrate for the removal of dicyanoaurate, accounting for over half of all gold extracted.

Activated Carbon & its Shortcomings

A major use of activated carbon in mining is in gold recovery, where granular activated carbon (GAC) is used for adsorption of the gold-cyanide complex in carbon-in-pulp (CIP) and carbon-in-leach (CIL) systems, or in carbon-in-column (CIC) systems after a heap leach operation carbon. Activated carbon comes in various forms, including extruded and high-quality broken grades for gold recovery applications. These activated carbons combine superior hardness with adsorption/desorption kinetics and capacity, resulting in fewer fines and associated gold losses.

Activated carbon is cheap to manufacture, absorbs gold readily, is fairly selective for gold, and has a large gold loading capacity. The downside is that activated carbon also has a high affinity for mercury (II) tetracyanide and under some conditions mercury (II) tetracyanide may actually displace dicyanoaurate from the activated carbon.

Additionally, regeneration of activated carbon is energy intensive and requires a fair amount of capital layout. Like dicyanoargentate (the silver species found in GCP), mercury (II) tetracyanide desorbs with dicyanoaurate when eluted from the activated carbon. Mercury (II) tetracyanide is also reduced to elemental mercury during the electrowinning process that isolates metallic gold.

The disadvantages this material has are:

- Stripping at High Pressure (50 psi) and High Temp (~160°c)
- Regeneration at 500-900°c
- Long Stripping Cycle Times (24-48 hours)

- Requires Complex Instrumentation

In addition to maintaining a high gold adsorption capacity, gold recovery carbons should be resistant to the highly abrasive conditions in gold recovery systems. This resistance enables the minimization of activated carbon fines formation, which is important to the process. Low fines production not only keeps carbon consumption as low as possible, but more importantly results in lower gold losses, as once carbon fines are generated they will adsorb gold quickly and leave the systems to the tails with the gold attached.

Activated carbon acts like a sponge to aurocyanide and other complex ions in solution. Hard carbon particles (much larger than the ore particle sizes) can be mixed with the ore and cyanide solution mixture. The gold cyanide complex is adsorbed onto the carbon until it comes to an equilibrium with the gold in solution. Because the carbon particles are much larger than the ore particles, the coarse carbon can then be separated from the slurry by screening using a wire mesh.

The carbon is mostly made of coconut shells, is not the most environmentally friendly and there is an attrition or loss rate with the carbon so more needs to be added to the extraction circuit over time.

The elution process is not 100% efficient for activated carbon and some traces of mercury remain on the activated carbon. Subsequently, upon thermal reactivation of the activated carbon, the mercury is thermally reduced to mercury metal, which then volatilizes and escapes into the atmosphere. The reactivation step is unavoidable as activated carbon also absorbs organic matter, which can foul and substantially reduce its capacity.

The Impact for Miners

Therein lies the problem for many gold miners as more than 10% of gold mined is lost in the cyanide solution using activated carbon. This comes at a huge cost for big producers like Agnico, Kinross and TMAC as a 200k oz/year producer could lose over $26mn annually just in cyanide solution and carbon inputs.

Case Studies - Major Gold Mines

	Nevada South		Mexico	
Improved Extraction Efficiency	$9,257,500	$57.50	$20,160,000	$180.00
Gold Lost to Residual Moisture	$618,361	$3.84	$2,467,535	$22.03
Gold Lost in Activated Carbon Fines	$10,465,000	$65.00	$4,368,000	$39.00
ADR OPEX Savings	$1,231,364	$7.65	$1,354,500	$12.09
Sustaining Annual Savings (Excludes Year 1)	$21,572,225	$133.99	$28,350,035	$253.13

On the preceding page can be seen a pair of case studies highlighting the problems (and financial losses) occasioned by the use of activated carbons. In the Mexican examples, the savings are particularly stunning.

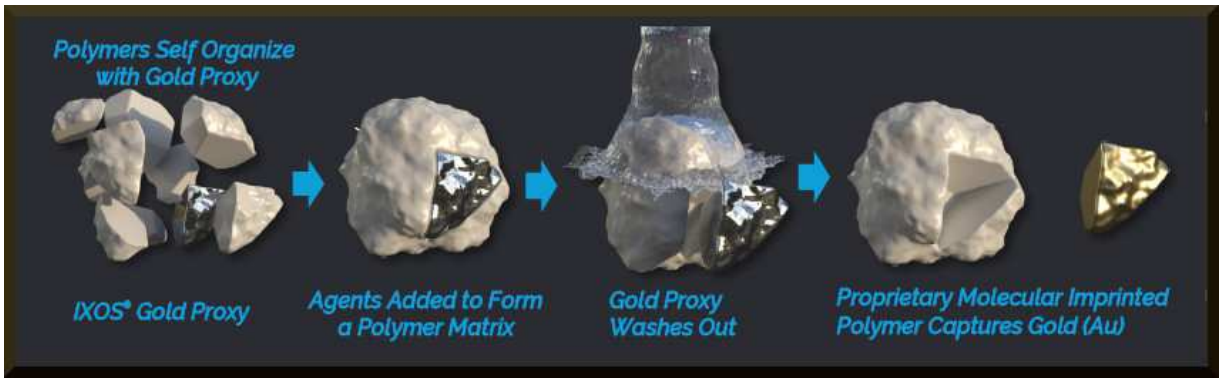
The Technology

The company utilizes advanced polymeric and non-polymeric chemistry to develop detection and extraction media that is powered by the specific molecular structure of the target substance. Since every substance has a unique size, shape, and chemical properties these attributes can be utilized at the individual molecule level to create highly efficient adsorption/detection media to solve problems that cannot be solved with conventional means.

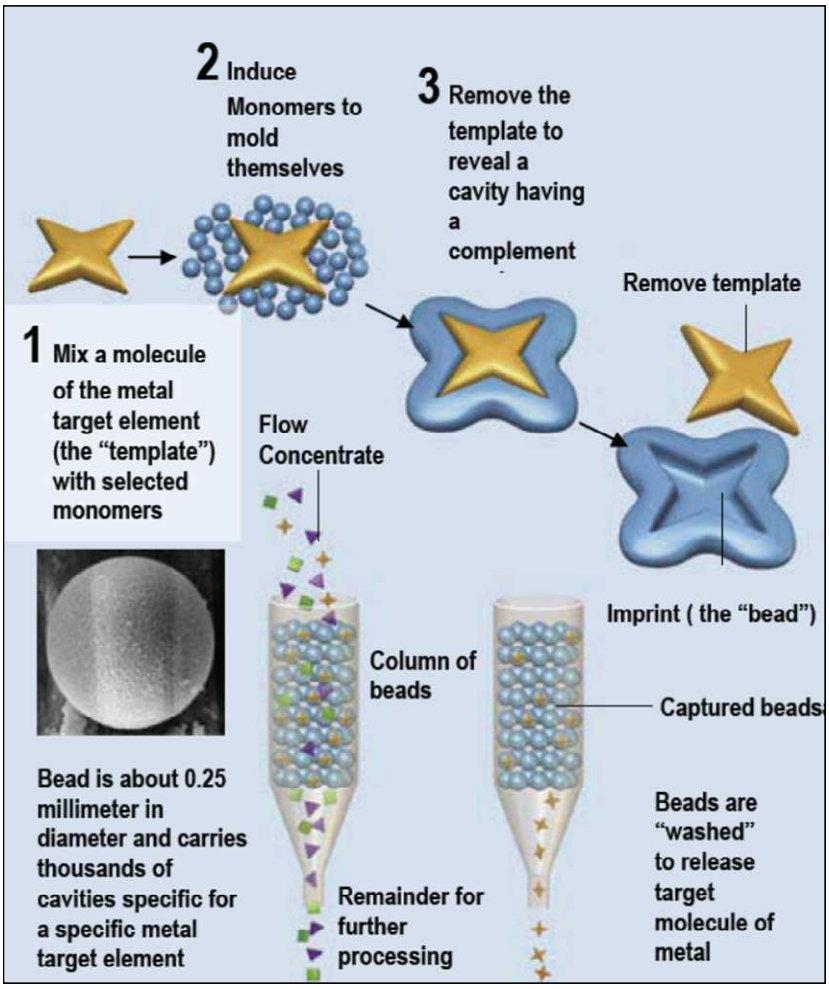
SIXW uses molecular imprinting to produce polymer beads specially formulated to capture a particular molecule. The case in point here is gold, but it could also be copper, nickel and especially important for lithium. It can be used with anything that is taken into a solution for extraction, including cannabis. Because it extracts at the molecular level, it is far more efficient with much better recoveries than current technology.

The process creates voids that match the shape of the gold (or other metal) particles and then the particles "complete themselves" by filling the voids. It is the principle of "nature abhors a vacuum" in evidence.

With gold mining, the bead technology has the potential to replace the current Carbon-in-Leach (CIL) material which is now used in about 500 operating gold mines. A prime attraction is that mines will not have to do any retrofit or significant process changes, instead they essentially replace the carbon with the polymer beads.



Below is another representation of the process. In some ways this strikes us as being the chemical equivalent of the Lost Wax Process used in casting:

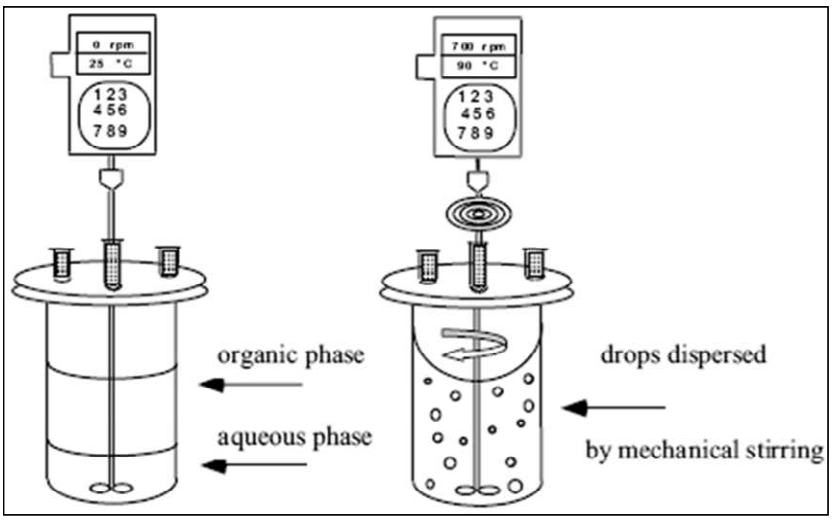


Compared to activated carbon the IXOS technology has to its advantage:

- No regeneration or descaling
- 3-hour cycle time
- Reusable eluent
- Less medium for adsorption/desorption & recovery system (i.e. 1/5 size of equivalent Carbon D.R.)
- Operated @ 60°C and no press required

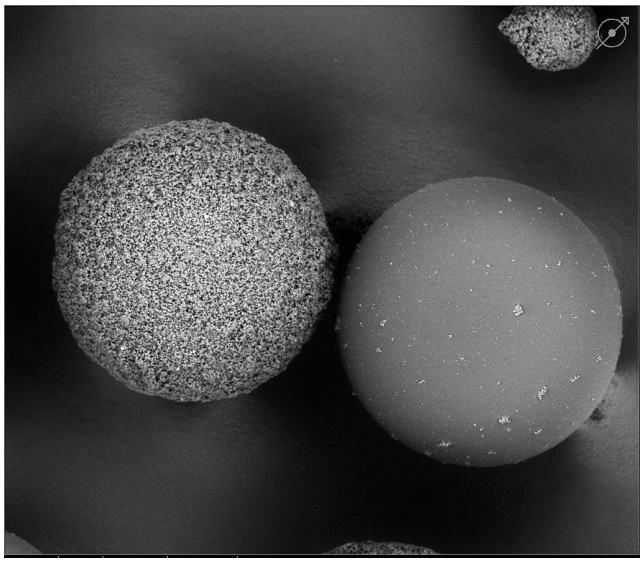
Bead Production

The actual production of the beads is shown in the schematic below:



In the first instance the imprint molecule is dissolved in an organic matrix, including monomers and initiator. Then there is a secondary aqueous phase that provides surfactants and thermal dampening. Then shear and heat applied to form droplets of desired size that polymerize and harden into beads.

When optimized, large, mechanically strong, and porous beads are formed. The beads, shown at the right, look like this when magnified by a factor of 500.



As can be noted from the table below the successive iterations of the polymer beads have increased yields at each phase and decreased the metal loss to a zero metal loss in the latest iteration.

Importantly, the capacity to imprint gold to each bead rose exponentially over the evolution of the beads rising from a fraction of a gram (per kilogram of beads) to nearly 25g in the latest generation.

Bead type	Yield (%)	Metal % loss during polymerisation	Au capacity (g Au/kg beads)
1st Generation	66	36	0.25
2nd Generation	50	10	1.53
3rd Generation	80	2	9.31
4th Generation	99	Nil	25+

A stark contrast between the Sixth Wave product and the veteran activated carbon product is the durability of the former over the latter. During testing Dicyanoaurate imprinted beads were repeatedly cycled (15X) through a simulated gold loading, elution and regeneration cycle and displayed the longevity of the polymer bead product.

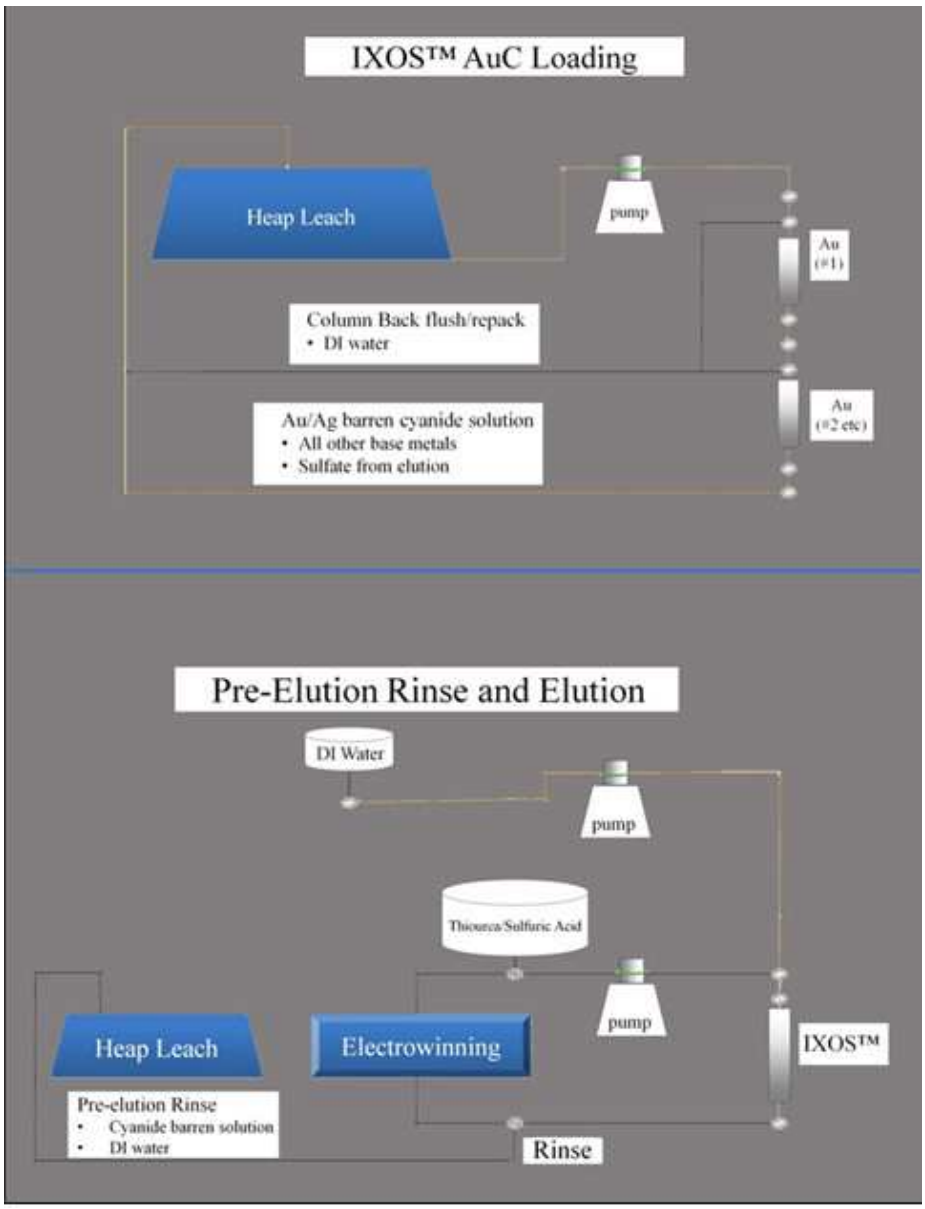
During the trials the pH varied from 10.5 to 1.5, with temperature swings from ambient to 50ºC, with large changes in ionic strength. Under these conditions the average bead showed an increase in capacity after the first cycle, then consistent loading capacity for the remainder of the cycles. As for attrition or wear, no swelling was observed, and there was only very minor loss of material after first cycle.

The beads are currently produced at the rate of a quarter of a tonne per day from a 1,000 gallon reactor. The toll contractor for producing the beads is Metals Technology Inc, which is headquartered in Illinois. Bead production is located at MTI's plant in Lafayette, Louisiana.

At the right can be seen a 50-litre polymer reactor. This is a typical reactor used for many things but for Sixth Wave, it is used to produce the beads. The lab uses a suspension polymerization process where the raw monomer components are added into a suspension to form beads. Adjustments in the suspension, mixing rate, and addition rate of the monomers are done to get a bead of the size and porosity that are optimal for the desired applications.

The Process

First we should note that polystyrene is the key component in the production of the beads. The beads vary in size according to the intended application but most are one or two microns in current gold extraction applications. Ergo it is not the beads themselves that are “nano”. They cannot be smaller or they would pass through the sieve with the lixiviant.



Polymer beads have durability as they can be used over and over, for at least three years.

Retooling to adopt the new technology is site specific as it depends on the type of mine and other

configuration specifics. In general the following applies:

- On the adsorption side some modification to the columns may be needed to ensure proper flow and bed expansion as the IXOS are smaller and slightly lighter than activated carbon
- On desorption it is felt that, in most cases, the acid wash tanks used to de-scale activated carbon can be configured to be used as the elution tank for IXOS
- Heating elements and pumps used for activated carbon strip can be re-used as IXOS requires a fraction of the heat for elution
- Electrowinning may need to be changed as the IXOS elution circuit uses acidified thiourea rather than caustic. This may require changes in tank materials to ensure pH compatibility

So it is essentially adaption of existing kit rather than installing totally new systems.

Elution

The elution process is when the beads (now with the gold embedded) have the metal "washed off" by the application of an eluent. The beads then become reusable.

One of the other advantages of molecular imprinted polymer beads over activated carbon is that miners can reduce their water consumption and needs. Water is an increasing preoccupation in many jurisdictions where indigenous people (and NGOs) are concerned about access to (clean) drinking water. The eluent is reusable and the size of the plant is much smaller.

We might also note that the eluent differs depending on the end-product that is sought. In gold the eluent is acidified thiourea, in Lithium it is a strong acid, such as hydrochloric acid, while in cannabinoid processing it is ethanol that is applied.

Kinross & IXOS

In August of 2017, 6th Wave entered into a contract with a subsidiary of Kinross Gold Corporation for the first on-site testing of its IXOS® beads for the extraction of gold from a cyanide leach solution. Both 6th Wave and Kinross data analysis demonstrated that the IXOS® beads captured significantly more gold and showed higher selectivity for gold than activated carbon.

On March 21, 2018, 6th Wave entered into a services agreement with a subsidiary of Kinross for the construction and testing of an adsorption, desorption, recovery pilot plant system (the ADR Pilot Plant). Under that agreement, 6th Wave was to install, operate and report on results of the ADR Pilot Plant. The system was installed on site on a secondary heap at the Bald Mountain Mine located in Nevada. In parallel testing against activated carbon, IXOS® beads exceeded activated carbon in terms of gold and silver adsorption and were more selective against copper.

The ADR Pilot Plant has been tested with 100% elution of metals adsorbed on the resin being released within a 90-minute elution cycle. The ADR Pilot Plant has since been moved from the secondary heap and is in the process of being installed and optimized to run on cyanide solution generated by the active processing heap at Bald Mountain.

The company is not currently piloting at any other sites. It has however run smaller pilot tests onsite at approximately ten mine sites, with positive results, and it is currently in negotiation with another mine for on-site testing and a possible pilot plant.

The Financial Benefits

The IXOS application saves about US$100 per ounce of gold mined. This saving is basically a calculation of the higher proportion of gold extracted from the same tonne of ore. All the major gold mining companies have been, or are starting to work, with SIXW. The aforementioned testing at Kinross's Bald Mountain gold mine has shown savings of over US$100 per ounce.

SIXW will license or make usage agreements where they will basically earn around 1/3 of the savings, (or around $30 per ounce of gold mined) with no costs. At $1500 per ounce, this equates to a 2% royalty.

Deal with Sumitomo

In a major endorsement of the perceived mass marketability of the MIPs technology, in recent weeks, Sumitomo Corporation of Americas has become a sales representative for its IXOS®-Au product line.

Further to a letter agreement executed October 15, 2019, SCOA will introduce and promote IXOS® to its extensive customer base in the gold mining industry and receive a 5% commission on applicable sales.

SCOA completed a rigorous analysis and assessment of Sixth Wave's disruptive IXOS® molecular imprinted nanotechnology used for gold extraction. SCOA is also interested in future Sixth Wave technological advancements for the extraction of other metals and contaminants associated with mining activities.

Sumitomo Corporation of Americas pursues productive marketing opportunities with businesses throughout the region offering full access to Sumitomo Corporation Group's immense global network of business enterprises in more than 65 countries. Over the past six decades, these relationships have strengthened, and business partners in the Americas have come to expect reliable business knowledge, corporate resourcefulness and quality services.

Deal with CyPlus

In April 2019, the company announced a sales and marketing representative agreement for IXOS® products with CyPlus GmbH of Hanau-Wolfgang in Germany. CyPlus is a regional leader in cyanides (NaCN and KCN) with strong technology services. It will represent Sixth Wave's gold extraction

technologies in Europe, Mexico, Turkey and Egypt.

As of August 2019 CyPlus GmbH is part of Röhm Group, a 100% subsidiary of Advent International. Founded in 1984, Advent International is one of the largest global private equity investors.

CyPlus's business model is the safe and responsible handling of cyanides across their lifecycle from production, transport & handling to application and disposal. It has around 100 employees worldwide, with production sites in Europe and Mexico (the CyPlus-Idesa Joint Venture) as well as sales offices on all continents.

The Lithium Angle

As mentioned earlier, the IXOS technology has applications in other metals and the prime focus is in expanding towards the Lithium brine space. In mid-March the company announced that it had acquired a controlling interest in Geolithic Corp. pursuant to its option agreement with Trilateral Energy, LLC.

Geolithic was established at the start of 2017 as a joint venture between Trilateral and Sixth Wave to exploit the latter's technology for the extraction of lithium from geothermal brines located primarily in the Salton Sea area of California. The Salton brines have elevated levels of lithium and other minerals. Under the 2017 agreement, Trilateral held 60% of the outstanding shares of Geolithic, with Sixth Wave held 40%. Under the terms of updated Agreement, Sixth Wave has now purchased an additional 15% controlling stake (for US$75,000) in the venture, with an option to obtain a full 100% before the end of 2020. The company then has the option to acquire the remaining 45% of the outstanding shares of Geolithic in exchange for payment of an extra USD$225,000 by September 30, 2020.

Sixth Wave has tested several product designs tailored to lithium extraction in complex brines where the separation of lithium from the background of salts and metals has proven difficult, if not impossible, using traditional technologies. These designs have focused on the utilization of the molecular imprinting techniques, as well as novel implementations of other nanotechnologies, including new designs for macrocyclic ligands and molecular sieves/membranes. The bead format of MIPs is not that suitable for high silicate brines (like those at Salton) because of the silicates precipitating into the same holes in the beads in which the Lithium must lodge.

While the Salton Sea is a particularly interesting opportunity, the company has also been testing material from the Clayton Valley in Nevada, where the material doesn't have the same silicate problem as Salton. Next step will be applying the technology to lithium-rich brines elsewhere in North America, South America, and beyond.

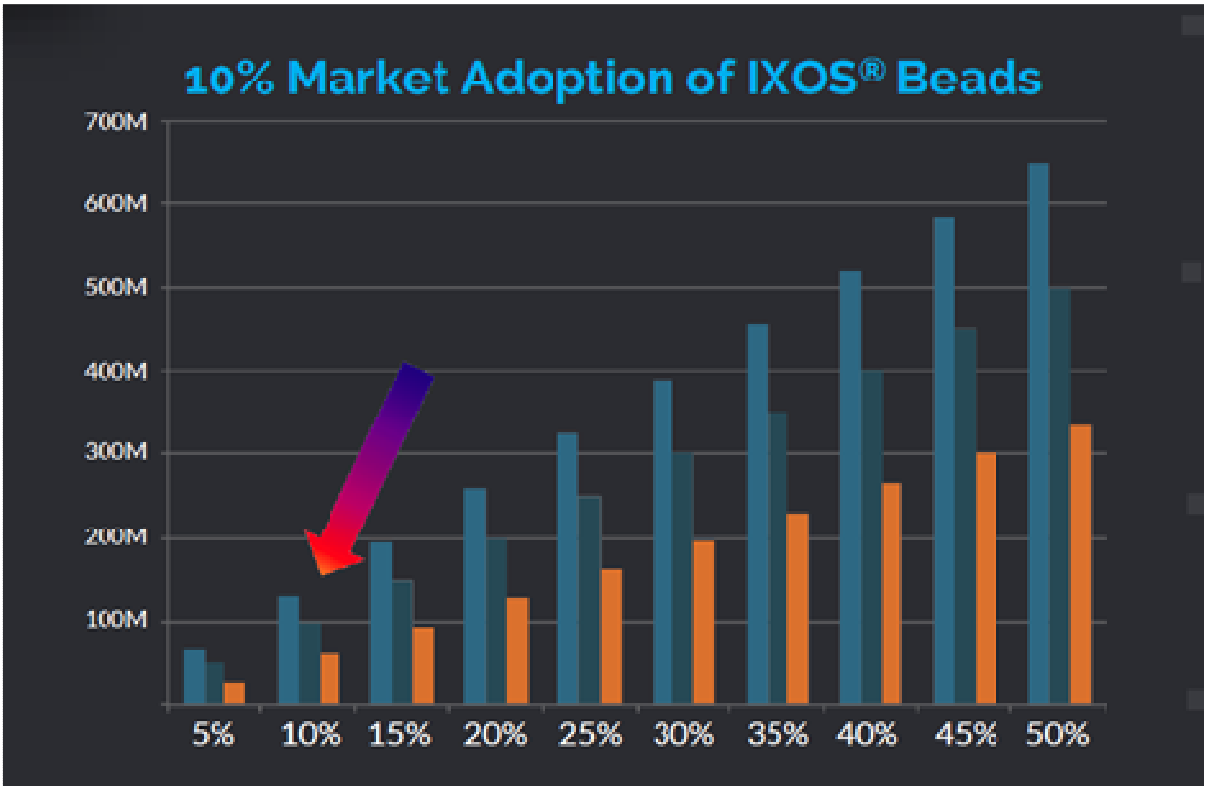
With its capability of capturing elements down to the lowest concentration levels (parts per billion or ppb) quickly and efficiently, Sixth Wave nanotech has the potential to eliminate the costly, time-consuming and environmentally hazardous evaporation ponds characteristic of current lithium extraction technologies. In some areas, such as the Salton Sea, the construction of vast evaporation

pond complexes may not be viable because of environmental concerns.

Sixth Wave has already applied for several patent applications for its technology in relation to lithium that are at various stages of review worldwide.

Potential Revenues

There are alternate ways in which the product can be monetized depending on the circumstance of the end-user. For customers that have capital the beads can be purchased and replaced every few years as may be needed. Alternatively, Sixth Wave can provide them at no cost and charge them an OPEX that essentially spreads the normal purchase cost plus a premium for SIXW's costs of carrying the financing. In either case the company can offer the miner a support contract as well that keeps the two parties involved in maintaining peak performance for the mine.



As it is not possible to know efficiencies at a mine that would be auditable such that revenue sharing would work. Moreover as SIXW is not in control of the usage, it therefore could not allow its revenue to be dependent on poor management at a mine. The company's pricing, either way, has been tested against many operating models from actual mine work and analysis with the mine. This ensures that when Sixth Wave pitches a project it has confirmed that usage of IXOS using either model is profitable for the mine. If the savings are of the order of $100, then it would be expected that the cost of Sixth Wave's product/service is around 30% of that savings.

Affinity - the CBD Application

Sixth Wave's valuation surge has been driven, in part, by its efforts to develop a commercially viable and highly competitive process for CBD and THC purification based on its IXOS® bead MIPs technology. The availability of pure CBD and THC allows for controlled specialty cannabis extract formulations for different medicinal indications and recreational adult uses. Pure CBD isolate, in particular, is desirable as a means of obtaining the medicinal benefits of CBD without the psychoactive effects of other cannabinoids.

Interestingly, studies have indicated that the majority of CBD products being marketed do not contain the amount of CBD indicated on the label and 20% contain some amount of THC.

Several technologies are currently utilized for the extraction of CBD and THC from cannabis extracts, including chromatography, extraction with organic solvents (e.g. pentane) and sub-and super-critical CO_2 extraction. A newer technology based on membrane extraction has been reported by Green Sky Laboratories.

Chromatography is the only process widely used to generate either high purity THC and CBD (or other cannabinoids) from the plant extracts. It is a labour-intensive process which can also suffer from incomplete purification (retention of residual impurities/undesired side-products). While larger variations of chromatography equipment exist, the overall process is not cost effective and is limited in scalability. This method also requires relatively pure cannabinoid material (e.g. terpenes and waxes removed) to improve efficiency and limit fouling of chromatography media (e.g. silica gel). Depending on the solvent system used, there are also cost concerns and safety concerns as some of the solvents needed for chromatography are toxic.

Sixth Wave has developed its Affinity™ Extraction Process to extract THC and/or CBD from cannabis/hemp for the production of pure THC and CBD compounds. Work so far has justified the company's view that the technology and process will provide a robust, cost effective method to provide high purity THC and CBD for the commercial market.

The Affinity Process

Sixth Wave has completed initial development of the beads and laboratory testing using synthetic crude extracts and laboratory prepared hemp extracts, as well, actual extracts from both CO_2 and ethanol primary extraction systems. Bench scale multi-column extraction testing has been completed in the laboratory and a small deployable bench test kit is under construction for testing at candidate processing partners.

The pilot unit is a simple counter-current flow system in a carousel configuration utilizing up to 30 columns of MIPs beads. At any given time, up to 24 of those columns are configured to collect the cannabinoid from a diluted crude extract. The remaining columns are simultaneously in either a cleaning

phase or extraction phase where the loaded cannabinoid is released from the bead.

The first pilot plant has been installed and is being commissioned at a major CBD processor. Below can be seen the Affinity Gen II, CDB/THC Purification Unit.

The existing methods for cannabinoid extraction from hemp and cannabis are only effective with small volumes of plant material and require significant CAPEX and OPEX costs. Producers must work with multi-stage processes to separate individual cannabinoid compounds. Ultimately as the industry grows the small-scale of operations so far must be replaced by vast processing plants with economies of scale otherwise margins will be resistant to improvement.

The benefit of the Affinity process is that the system has a much higher throughput of material and works within a closed-loop environment. This continuous, closed-loop system has negligible material loss which leads to higher recovery rates. More than 15% of cannabinoids can be lost through the use of traditional extraction processes.

The extraction process works within ambient conditions with no harsh solvents, uses food grade equipment and does not require highly skilled labor to operate.

The MIPs in this instance capture specific molecules by passing mixture of plant crude and ethanol though a column (as pictured above). The beads capture the targeted molecules instantly and are also instantly removed (eluted) from the beads with a second ethanol cycle.

To the right can be seen the crude extract and below left the finished distillate, while at the bottom right is the CBD isolate.

The removal of pesticides, heavy metals and other contaminants are a major industry problem as new standards are being introduced for strict removal of these nuisance materials. As the contaminants are never targeted by the Affinity™ Beads, they simply pass through the column.

Ramp-Up

With the CBD space being one of the fastest moving sectors around, the company has deployed a rapidly reconfigurable pilot Affinity™ Alpha plant at a major US hemp processor. The system is being used for performance optimization and development of Standard Operating Procedures (SOPs) for generating isolates and THC free full spectrum distillates.

Meanwhile the company is engaging contract manufacturers to produce the Affinity Alpha line of

purification systems with the goal of having manufacturing in North America and the EU with the units built to meet the rigors of US, Canada, and EU Good Manufacturing Practices (GMP) certification allowing any cannabis processor using the Affinity™ Alpha systems to obtain such certifications for their facility.

On the MIPs side, it is transitioning manufacturing of the beads to its bulk manufacturer. The beads will be produced using all Generally Regarded as Safe (GRAS) chemicals and the manufacturing plant/process is already certified GMP. The scale up will result in the beads being manufactured in a 1,000-gallon reactor which will give the ability to create over 1,000 kgs of beads weekly.

First Sales

In early April, the company announced the execution of a Memorandum of Understanding with Green Envy, LLC for the purchase of a minimum of three Affinity extraction units for the production of full-spectrum distillates.

The new client, Green Envy, is a cannabinoid extraction company specializing in the production of concentrates, distillates and edibles. The company sources its input feedstock from select growers in the states in which it operates; then applies controlled heat, pressure and natural ethanol processes to produce cannabis extracts, without the negative impacts of hydrocarbons, CO_2, or pesticide remediation.

In the short-term, Sixth Wave will prepare an initial Affinity Unit for delivery, installation and commissioning at a Green Envy facility in Riverdale, Michigan.

The terms of the deal are interesting and give an indication of the way future arrangements with uptakers of the technology might be formulated. In the case of Green Envy, the MOU contemplates the purchase and delivery of the units pursuant to the terms of a Total System Performance License (TSPL) to be finalized by the parties. The term of the TSPL is expected to be three years, with automatic renewals for additional three-year terms. Initial equipment set-up fees and ongoing royalty fees (to be applied on a per-gram basis of produced distillate) applicable to the Affinity System will be specified in the finalized agreement.

The MOU provides Green Envy with a twelve-month exclusivity period (a First Mover provision) to utilize the Affinity System for the cannabis market within the states of Michigan and Massachusetts. The production of products derived from hemp is excluded from the First Mover provision.

Revenue from CBD

The revenue model for CBD products is similar to the mining, in that if the miner regards the beads as part of CapEx they would purchase beads by the ton at a fixed cost with expected replacement every two years or so. If classified as OPEX, then they are billed monthly and replacement of the beads is inclusive of the long term contract.

The table that follows shows the pricing and economies model for the applications in the CBD space. Essentially the biggest saving for the client is at the front-end with lower capex and then the company has greater volumes (through higher recoveries) and some residual cost savings after SixthWave has gleaned revenues via its "usage fee" which is linked to savings achieved.

CapEx	USD
Affinity	$175-$200K
Chromatography	$1.5 - $2mn

OpEx

An Affinity Unit processes:

20 litre per day of finished (distillate) product

Opex savings 25cts/g or $250 per litre/kg

Affinity produces 15-30% increase in output over alternatives

versus

Chromatography loses 10-15% of output

versus

Distillation loses 25-30% of output

---

20 litres per day at savings of $250 per litre amounts to $10K per day, of which 80% accrues to Sixth Wave.

Advantage to producer is higher volumes and dramatically lower capex for the unit.

The pricing model is somewhat like leasing. Pricing though can also be linked to revenue or production volumes. With production of the Affinity machines (like those in the Green Envy transaction) producing around 1kg per hour of distillate or isolate, one could posit around 20kgs per day of production with SixthWave collecting 20-30 cents per gram or $ 4-6,000 per day.

Health Sciences – Grappling with Coronavirus Testing

SixthWave has had its virus-testing potential for the MIPs technology under deep cover for a long while. With the other two "pots on the boil" of CBD and mining applications this was understandable.

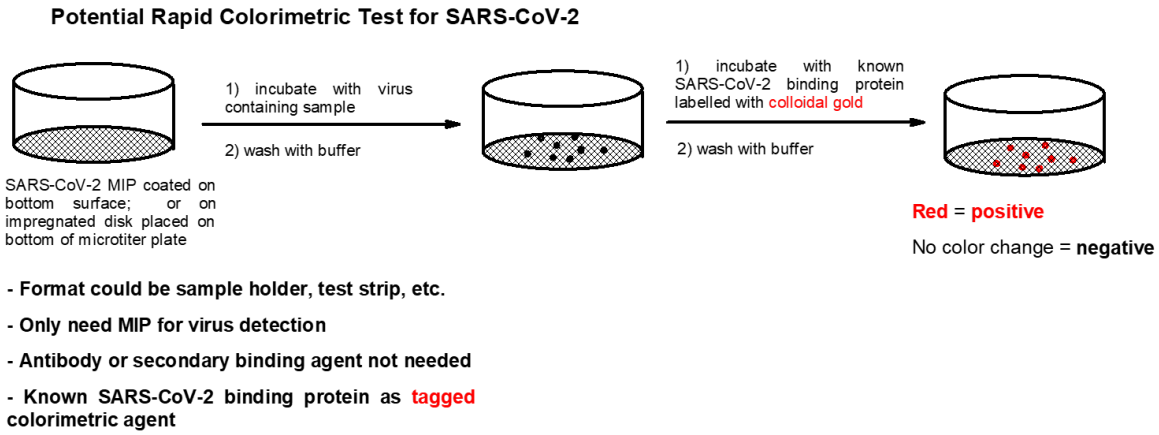
However, events have overtaken the company in the last month and resulted in the accelerated unveiling of the technology in the hope that it can contribute to the global push to identify those positive for the virus and aid in the process of discovering ways of ameliorating its effects.

Much as the company would prefer to have a cure to hand its technology is related to the almost as important aspect of quickly testing patients for infection using Rapid Diagnostic Tests (RDTs). RDTs are key screening tools to rapidly process large numbers of patients, often designed to be administered by unskilled technicians. The tests must be fast, accurate, and inexpensive relative to other techniques. As a first line of screening these tests can be over 90% accurate and quickly determines if the patient warrants the expenditure of more resources.

Clearly there is not time to develop a novel MIP after a new outbreak has occurred. To be able to respond rapidly to a new outbreak and rapidly develop a new diagnostic, SixthWave's research team have been working to build a family of MIPs based on the general shape, size and morphology of generic classes of viruses. These would provide a set of adaptable testing building blocks that could then be almost plug & play.

These would be prepared utilizing virus surrogates and/or attenuated or inactivated viruses (non-infectious). The MIPS would be part of an inventory ready to immediately be deployed for screening against a new threat. The most selective MIP would be further incorporated into a previously defined format for use in the diagnostic platform system. As the MIP chemistry is already known, direct scale-up to manufacture could be initiated immediately and applied to kits that are already able to be mass produced.

For a viral threat such as SARS-COV-2, recognition of the intact virus would be the most efficient process timewise. This may be done via the availability of a MIP that recognizes/binds the virus. The image below shows how the MIP being used to produce a testing mechanism that highlights positive carriers.



The key component of the SixthWave research has been a system for virus detection based on

antigen/antibody recognition. The process is divided into three stages:

1) immobilization of antibody on a substrate
2) migration of viruses to antibody
3) binding of viruses and antibody

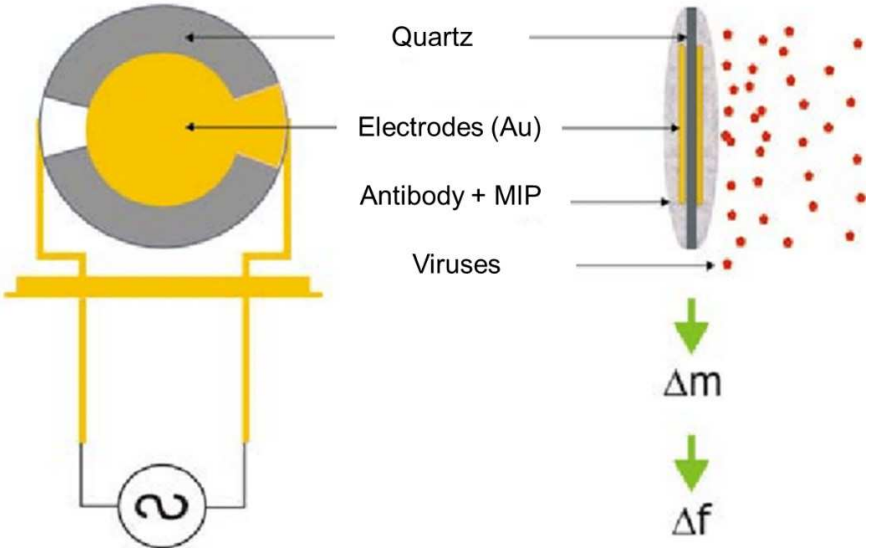
Sixth Wave contends that its MIP technology has the same recognition capabilities and can directly replace the antibody in this binding interaction.

In the present proposed diagnostic, the virus is bound to the Sixth Wave MIP via a highly selective molecular recognition process. Virus detection is achieved by various sensing techniques based on the binding event.

Three suggested detection approaches compatible with MIPs include:

1) quartz crystal microbalance (QCM) sensor
2) lateral flow immunoassay
3) electrochemical sensor

A QCM sensor is a kind of mass sensitive sensor. The basic material of the QCM sensor consists of quartz crystal, which is equipped with metal electrodes (e.g. gold). A sensor surface is modified with coating of MIPs, which is used to enable detection of viruses. An appropriate electronic circuit is necessary to make conversion of the measured virus quantity to an electrical signal. The basic working principles of the quartz crystal microbalance sensor are displayed below:



Viruses that are present in the surrounding solution of a QCM sensor will interact with the sensor surface. In this interaction, viruses are bound to the MIP. The bound virus results in a mass change on the sensor surface. Consequently, the mass change on the sensor surface is converted to a frequency change. A QCM sensor is a useful tool for biomolecule detection and it has advantages such as high sensitivity, low response time, continuous operation, portable device, label-free, and real-time detection ability.

QCM biosensor systems are composed of three components which are receptor, transducer, and signal monitoring system.

At the current moment of a massive global scramble by the healthcare industry the need is for rapidity of development of detection tools. Sixth Wave's technology has the potential to finish development and scale quickly. This is due to the fact that immunoassay based RDTs are reliant on animal surrogates for the production of new antibodies which may take 2-3 months. Initial design and development of the flexible platform will take 6-12 months, but after the platform has been developed, new product development would follow the table listed below:

Steps for RDT Development	**Sixth Wave**	**Immunoassay**
New Virus Identification and Characterization	30 Days	30 Days
Development of new RDT	1-2 Months	3-6 Months
Clinical Validation of RDT	30 Days	$14,676

We live in dramatic times and rapid solutions are required. That SixthWave's team were already on this even before it became an issue of global importance is telling, not only of the team's wide-ranging approach but also of the myriad possibilities opened up by the MIPs concept.

Management & Team

The company has seen a gradual reorganization of its management that matches its evolution. At this point in time the original funders have evolved into new roles and the technical crew has moved to the forefront to highlight the scientific underpinnings of the product range.

The President & CEO now that the listing has been accomplished is **Dr Jonathan Gluckman**. He has a 25-year track record of innovative, technology-driven achievements. As founder and CEO of Integrated Dynamics, a government engineering services company since 1996, he focused on the development and subsequent transition of advanced technologies into commercial applications. As the leader of 6th Wave since 2012, he has concentrated his efforts to complete IXOS®, in the metals processing industry. He holds a Ph.D from the University of Cincinnati.

Dr. John Veltheer, an executive director and CFO, is a veteran public company director with whom we collaborated on projects early last decade. He has completed numerous public listings and reverse merger transactions over a broad cross-section of industries. Since August 2016, he has been the Chief Executive Officer, President and a director of Atom Energy Inc.. He obtained his BSc (Hons) in Chemistry from Queen's University in 1988 and his PhD in Inorganic Chemistry from the University of British Columbia in 1993.

Jim McKenzie, a non-executive director, is well known in the Rare Earths space for his roles as the President & CEO of Ucore Rare Metals, a developer which we have covered significantly in the past. He is an entrepreneur with over 30 years' experience managing, owning and operating companies within the Canadian private and public equity sectors., a publicly traded mineral exploration and development company, a position he has held since 2006. He holds a Bachelor of Commerce degree from Dalhousie University in Halifax.

Peter Manuel, a non-executive director, has been Vice President and Chief Financial Officer of Ucore, a publicly traded Rare Earth exploration and development company, for the past nine years. Prior to that he was engaged as a Chartered Accountant for 17 years providing consulting services to companies in a range of sectors, with a focus on the financial services and resource sectors. Mr. Manuel holds a Bachelor of Commerce Degree from Dalhousie University.

Scott Robinson, a non-executive director, began his career as a business analyst in the construction industry, servicing the resource sector. He has extensive experience in the capital markets, analyzing projects and raising funds in both the resource and technology sectors. He holds a Bachelor of Commerce Degree from the University of Alberta.

On the technical and sales team there is also **Sherman McGill,** a 6th Wave founder and sales and business development executive with a long track record of developing multi-million-dollar R&D programs, and providing product sales and training services to high profile US and international customers. He has played an integral role in developing international brand and product acceptance for three start-up companies.

Dr Aris Kalivretenos is responsible for new product development and commercialization of Molecularly Imprinted Polymers (MIPs) for life science applications, including pharmaceuticals, natural products, food safety, healthcare and drug detection. He has performed a post-doctoral fellowship focusing in the CNS area at Columbia University after earning his PhD in organic chemistry from Colorado State University and a BS in chemistry from Clemson University.

John Cowan is the Chief Operating Officer. He started his career as an engineering craft apprentice and additionally gained many years of relevant college education including a BS Honors Degree in Mechanical Engineering. His experience includes over 25 years with the Eaton Corporation in Europe & USA in all levels of leadership within the Operations Engineering and production quality disciplines. He is overseeing the production ramp-up and management of Sixth Wave's Affinity™ Cannabinoid

Purification and IXOS® Gold Extraction platforms, as well as overseeing new product development and roll out.

Risks

The potential risks are:

- Slow uptake of the new technology in the mining space might work against achieving critical mass and economies of scale
- Application's adaptability for other metals is not as advanced as for gold
- The Rapid Detection Testing applications are still in trial mode and may "miss" the current Coronavirus crisis
- Regulators are all over the CBD space attempting to control the phenomenon and "be seen" to be controlling it. This could result in a glacial trialing and approval process for treatment systems
- Excessively slow approvals might mean that "producers" gearing up for the boom install the currently approved kit and then are reluctant to retool when new systems are approved

As mentioned earlier in the review, the forces of conservatism in the mining engineering industry are entrenched and regard any innovation with scepticism. The key here will be proving the enhanced recoveries and the uptake of the technology by industry leaders which will offer a "seal of approval" to those smaller operators who look to the biggest operators for validation. Having Kinross as an early adopter is key. The attraction of higher recoveries is an enormous incentive for early adopters of this technology.

In CyPlus and Sumitomo the technology has two well-positioned advocates/marketers of its product range. They are also prominent in the cyanide distribution space so clearly regard IXOS as complementary to their own product range.

The Coronavirus crisis is an unknown this point as to its ultimate implications, its duration and what (if any) "cure" may be found. SixthWave's timing is propitious but whether it will be able to bring its product into play fast enough, even with burning the midnight oil, remains an unknown.

The whole CBD "industry" is a moving target at the current time. It is evolving rapidly, indeed, much faster than regulators foresaw and they are somewhat vainly trying to reassure the public that they have a grip on its evolution. Moreover the activity is transforming from a cottage industry with shady operators to a major industry dominated by multinational players (probably Big Pharma and Big Tobacco). These operators are used to taking on new processing technologies and will want equipment and purification plant that is massively scaleable and that meets their exacting sanitary standards. They are used to "getting ahead" of regulators on quality and purity issues, so will be seeking solutions that do not turn around and embarrass them or compromise their products quality in the eyes of consumers.

Regulators are slow-moving at the best of times. However with governments seeing CBD as a big potential money spinner for their perpetually squeezed finances there is an incentive for faster rather

than slower acceptance of new techniques. Additionally governments tend to favour higher purity or sanitary standards over lower to avoid potential voter blowback if a contamination scandal breaks out.

Conclusion

With applications running the gamut from mining through CBD to health sciences (and beyond) the MIPs technology evolution is proving to be right time and right place. A difficult feat to pull off.

Gold recovery rates are a perennial problem for that segment of the mining industry and with gold again on the rise managements despair of sub-par recovery rates from their CIL/CIP systems. Carbonaceous matter and other materials can reduce gold extraction during cyanide leaching by adsorbing dissolved gold from the pregnant leach solution. Despite this there has been little they could do to remedy this loss of gold from the circuits.

Upon the scene we now have the arrival of Sixth Wave with its innovative MIPs product range, which work within the broader confines of cyanide leaching, but are essentially looking to elbow aside the sub-optimal employment of activated carbon in CIL/CIP modes of extraction. With Kinross as an early adopter, Sixth Wave, has been able to short-circuit the traditional reticence of the mining community to experiment with alternative processes. Already the use of MIPs has shown potential savings of US$100 per ounce which will add substantially to the bottom lines of those currently utilizing CIL/CIP systems. Even moving the dial on recoveries by several percentage points could make for quantum increases in margins.

In an example of the adaptability of MIPs, the applications in virus detection were on ‘slow-burn” for the company but have now been pulled from the back-burner to active development due to the tragic global spread of the Coronavirus.

SIXW's core focus has been, up until now, Gold Extraction and Cannabis Purification, however, with its patents and products that address broader mining and environmental cleanup applications as well as other life sciences applications (such as zoonotic virus detection) the potential to multiply areas of application is obvious. The company continues to develop products in these other fields with a focus on problems addressed with its nanotechnology solutions. In particular a number of other minerals show potential to employ the MIPs.

On a broader scale, the company has entered the fray of the burgeoning cannabinoid processing field, with a focus on purification systems. While several technologies have become entrenched early on because they were pre-existing the scaling up by the bigger players is to such an extent that the field is wide open for technologies to “muscle in” and stake out a position. The Affinity product addresses various refining and purification issues that preoccupy producers of CBD products (and the regulators) and is now into its second generation of the technology.

The company is adopting revenue models that owe more to the tech space than they do to the mining space. Instead of plain licensing of technologies it remains in control of either the “secret sauce” of the “secret sauce dispenser” and is working with pricing models that take part of the savings rather than flat fees or rentals. With increased volumes and increased reveries, at lower production costs, the end users won’t be able to exercise much pushback against the model SixthWave decides to implement.

We are affording Sixth Wave a **LONG** rating with a 12-month target price of CAD$1.70.

Important disclosures

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